

HYDROPHYTIC VEGETATION OF COURTALLUM, SOUTH INDIA¹

K. K. N. NAIR²

(With two text-figures & a map)

This paper attempts to present an outline of the angiospermic aquatic vegetation of Courtallum, Tamil Nadu, India. It covers a discussion of the varied habitats of the plant group in the area, an ecological classification, a table giving the relative distribution of each species, a study of their phenology and certain field observations on the vegetation type.

INTRODUCTION

Courtallum (Kuttalam), the well-known area of botanical interest on the Western Ghats of Tamil Nadu State lies between 8° 50' and 9° 0' N. and 77° 10' and 77° 20' E., about 86 kilometres from Tirunelveli town and about 7 kilometres from Tenkasi railway station. It is a few miles south of Achenkovil and Aryankauv Pass of the Western Ghats, connecting this portion of the country to Kerala. Courtallum is situated on the eastern side of the Western Ghats facing the Aryankauv Pass and is bounded by Kulathurpuzha and Papanasam reserve forests on the west and south sides and the plains of Tenkasi and Shencottah taluks on the eastern and northern sides. Courtallum is dominated by the mountain chains of the Western Ghats, rising to about 1600 metres in height. The place is of repute in South India for its fine water falls, delightful forest scenery, a temple of antiquity and during certain months of the year an exceptionally cool and healthy climate.

The climate of Courtallum is the 'tropical montane' type and in the climate classification of Thronthwaites and Hare (1953) the area comes under the 'moist subhumid' region. As Courtallum lies opposite to Aryankauv Pass of the Western Ghats, it receives both southwest (June to September) and northeast (November to January) monsoons with a short gap in between. A monthly average rainfall for the last ten years (1965-75) shows that it varies from 1.24 cm in February to 24 cm in July. Normally a total of 100 to 200 cm of rain precipitates annually. In the mountainous environment of Courtallum the hottest months of the year are April and May when the temperature exceeds 38°C in some of the hot, sunny, days. During the hot months, the temperature never goes below 19°C. But in the southwest monsoon period it ranges within 19-34°C. The lowest minimum temperature recorded for the area is 17°C for the last ten years (1965-75). The main soil types of the area are red soils, laterite, black soils and humid soils and their mixtures in various proportions.

To correlate temperature and rainfall data and to record the drought period in Courtallum which is significant in the study of hydro-

¹ Accepted May 1978.

² Central National Herbarium, Botanical Survey of India, Howrah 711 103. *Present address*: Central Plantation Crops Research Institute (I.C.A.R.), Kasargod-670 124.

phytes, the rainfall and temperature data for the year 1975 is represented monthwise as an Ombrothermic diagram (Fig. 1). While plotting, the scales used is double in the case of temperature (in °C) when compared to rainfall (in mm). In the resulting graph wherever the rainfall curve passes below that of the temperature it indicates the span of the drought period in that year.

Hydrophytes at Courtallum are mainly seasonal and are distributed along the banks of mountain streams, in marshes, ditches, ponds

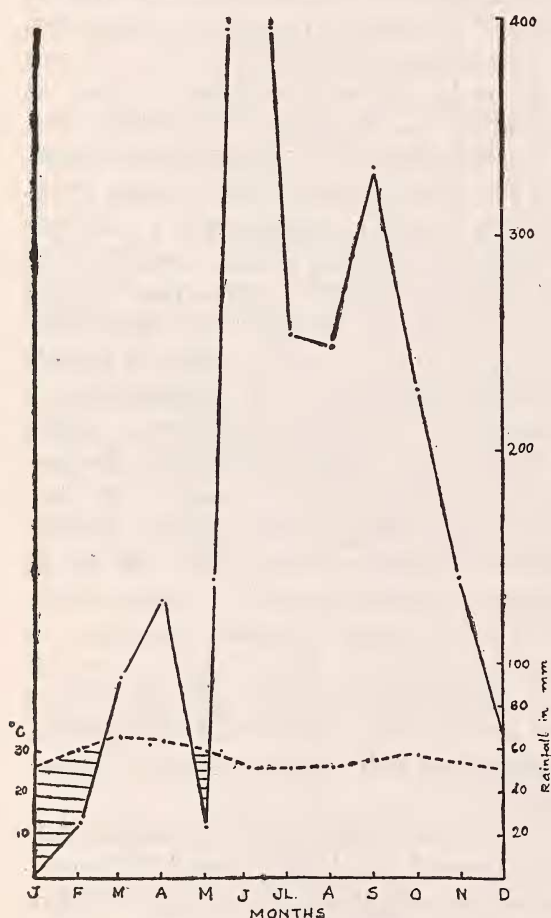


Fig. 1. Ombrothermic diagram for the year 1975.

and such localities. Weaver and Clements (1929, 1938) define hydrophytes as “plants that grow in water, in soil covered with water or in soil that is usually saturated with water”. Muenscher (1944) considers true hydrophytes as “those species which normally start in water and must grow for at least a part of their life cycle in water, either completely submerged or emerged” in which he included some ‘borderline species’ and terrestrial plants along the sides of ponds, lakes and streams which dries up during summer and thus grow in water only for a short period which according to Muenscher (1944) are not truly aquatic. In this connection the definition given by Daubenmire (1947, 1956) is somewhat satisfactory and to him “hydrophytes include aquatics which normally grow in water, and swamp and bog plants which inhabits soil containing a quantity of water that would prove supraoptimal for the average plant”. However, the plasticity shown by the members of this group to suit to a variety of aquatic conditions as discussed by Saxton (1924) while elaborating his concept of ‘mixed formations’ makes it practically impossible to define it precisely and comprehensively. While studying the hydrophytes of Courtallum, especially during the changing seasons this became more evident and several plants survive in a variety of aquatic habitats.

HABITATS

The wet banks of the hill streams Chittar, Palayakuttalam Aruvi (Old Courtallum river) and Aindalai Aruvi (Five falls river) (see map) hold the major part of the hydrophytes of Courtallum. In addition to this, the two ponds on the boundary of Courtallum reserve forests, Thippakkulam near Courtallum township and Thamarakulam on the way to Five

falls about 4 kilometres from the former towards the western side of the area and the wet gutters, ditches, puddles etc. formed seasonally harbour a few aquatic and semi-aquatic plants. The habitats characteristic of the plant group in the area are discussed briefly.

Streams and their banks:

Hydrophytes confined to this habitat are mostly those species growing along the banks of those mountain streams traversing the area. Towards the centre of the streams, as there is a constant water current, practically no hydrophyte can flourish except for those free-floating algae, prostrate bryophytes which are fixed to the underlying rocks and species like *Polypleurum stylosum* (Wt.) J. B. Hill which has its roots in the underlying or bordering rock.

In Tekkumalai, along the banks of the river Chittar few aquatic and semiaquatic plants grow. This reduction in the hydrophytic flora is due to the fact that the edge of the streams here is steep leaving little base for foot-hold for the plants. Swampy or marshy conditions do not exist. Rarely sandbanks are formed here and there but with a poor vegetation, that too mainly mesophytic. It is in the course of the stream here that *Polypleurum stylosum* (Wt.) J. B. Hill, grows with its thalloid body attached to the underlying rocks by means of hairs or 'heptera' thus preventing it from being washed away in the current. The plants are restricted to the shallow but swift flowing areas above rocks. Along the sides of the stream here are species like *Commelina ensifolia* R. Br., *C. paludosa* Bl., *Bergia ammannoides* Heyne ex Roth, few algae and bryophytes. During monsoon, in several of the canals and marshy spots formed in Tekkumalai, plants like *Oxalis corymbosa* DC., *Biophytum intermedium* R. Br., *Hydrocotyle javanica* Thunb., *Eragrostis gangetica* (Roxb.) Steud.,

Paspalum conjugatum Berg. etc. which are otherwise truly mesophytic growing in semi-hydrophytic conditions.

Along the banks of the river Chittar from Shembagadevi at about 2 kilometres from the foot hills to the Main falls in the vicinity of Courtallum township, a luxuriant growth of aquatic plants occur, as the stream here is shallow and slow-flowing and the banks possess several marshes, puddles and stagnant areas. During monsoon when the stream is full, most of the wet-land species disappear, but as the water level descends, the wet banks and marshes left behind form the natural abode for such plants. Some of the species rather confined to this region are *Drosera burmanii* Vahl, *Xyris pauciflora* Willd., *Cardamine hirsuta* Linn., *Aneilema montanum* (Wt.) Clarke, *Murdannia loriformis* (Hassk.) Rolla Rao et Kammathy, *Ludwigia perennis* Linn., *Eriocaulon* sp., *Echinochloa colonum* (Linn.) Lamk., *Lindernia ciliata* (Colsm.) Pennell, *Utricularia graminifolia* Vahl, *Didymocarpus innominatus* Burt et al. etc. of which the last mentioned plant is truly mesophytic in its natural habitat. In the stagnated pockets of the stream occur floating plants like *Ludwigia perennis* Linn. with floating roots and *Utricularia* sp. with filiform stem and roots and upright scapes bearing rose coloured flowers. Above Main falls, as the stream slows down, a marsh or puddle system is formed during the summer, where species like *Canscora heteroclita* (Linn.) Gilg, *Hoppea fastigiata* (Griseb.) Clarke, *Xyris pauciflora* Willd., *Elatine triandra* Schkr., *Amischophacelus axillaris* (Linn.) Rolla Rao et Kammathy, *Murdannia dimorpha* (Dalz.) Bruck., *Bacopa monnieri* (Linn.) Wettst., *Lindernia crustacea* (Linn.) F. Muell., *Torenia travancorica* Gamble, *Alternanthera sessilis* (Linn.) R. Br. ex DC. etc. grow. The most characteristic species of this community is

Canscora heteroclita (Linn.) Gilg, forming elegant stands with green, winged stems and pink flowers. Emergent amphibian hydrophytes like *Limnophila heterophylla* (Roxb.) Benth. exhibiting heterophylly is common here in the marsh in almost terrestrial conditions. Several sedges and grasses form the borderline species to those truly aquatic plants here. Below the falls along the sides of the pond in front of Courtallum temple, grow a few aquatics like *Lindernia pusilla* (Willd.) Boldingh, in summer when it is dry. Species like *Hydrolea zeylanica* (Linn.) Vahl, *Sporobolus diander* (Retz.) P. Beauv., *Mariscus compactus* (Retz.) Druce, *M. panicens* (Rottb.) Vahl etc. occupy the sides of the stream on wet ground along with a more characteristic species *Ipomoea pescaprae* (Linn.) R. Br.

During monsoon when the soil between the rocks above Chittaruvi (a bathing spot and cascade about 200 metres west of Courtallum proper) become marshy, *Sopubia delphinifolia* (Roxb.) D. Don with its characteristic green fleshy stem, filiform leaves and prominent rose coloured flowers become gregarious. Unlike several other aquatic species, the plants are erect rooting only basely. Fleshy plants with spreading branches and rooting lower nodes like *Commelina ensifolia* R. Br., *Cyanotis cristata* (Linn.) D. Don, *Bacopa monnieri* (Linn.) Wettst., *Lindernia antipoda* (Linn.) Alston, *Lindernia crustaceae* (Linn.) F. Muell. form a community in this area during rainy season, but in the remaining part of the year they are mesophytic. Except for the few species mentioned, Chittaruvi area is poor in Hydrophytes as also is the Tiger falls area about 200 metres east of Courtallum township, where, in the course of the stream temporary sand beds are formed bordering few semiaquatic plants like *Polygonum glabrum* Willd.

and *Utricularia polygonoides* Edgew. along the banks of the stream. During summer the stream dries, leaving practically no trace of the more hydrophilous plants excepting *Polygonum glabrum* Willd.

At New falls in the interior of the forest above Tiger falls, the aquatic vegetation is more characteristic. As the streamlet here, in the course of its descend, comes down in several steps on the face of the rock with pockets of marshy soil deposited here and there, several aquatic plants like *Eriocaulon quinquangulare* Linn. and *Utricularia graminifolia* Vahl grow. *Utricularia striatula* Sm. grow abundantly carpeting the wet faces of the rock in large patches. Below the falls, in the stagnant water and marshy soil between rocks *Ludwigia octovalvis* (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven form large clumps with a highly spreading root system, all over the rock covered with soil. *Cyperus tenuispica* Steud. is yet another common wet-land species of the area. The stream is perennial and the aquatic vegetation here flourish in the post monsoon period also.

In the stagnant areas below the reserve forest boundary on the way to Old Courtallum, species like *Polygonum glabrum* Willd. grow in truly aquatic conditions with the vegetative portions almost completely immersed in water, that is an anchored submerged hydrophyte, with the inflorescence emerging above the water level. In the forests around Old Courtallum with several rivulets of the Palayakutalam Aruvi there are plants like *Pouzolzia pentandra* (Roxb.) Benn., *Bergia ammanoides* Heyne ex Roth, *Cyperus pilosus* Vahl etc. in semiaquatic conditions. Aquatic vegetation of this region is quite scanty when compared to that found in other parts of Courtallum.

Along the banks of the river Aindalai Aruvi

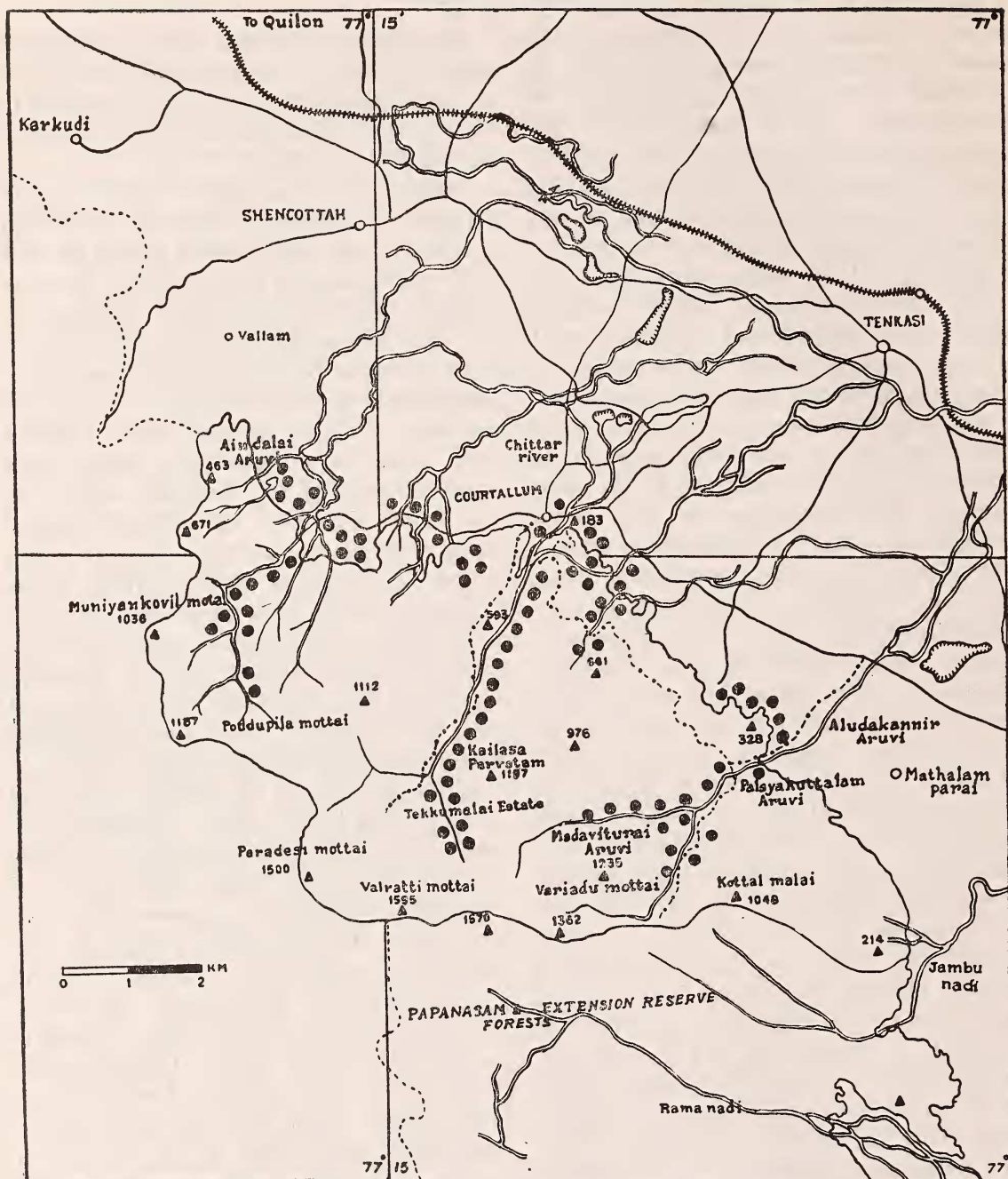
at Five falls and above it, and especially around Swamiar falls in Udayathan estate above, several hydrophytes grow. Even though the stream here is almost perennial, its flow is considerably reduced during summer. The most characteristic growth of this locality is found at Swamiar falls, where the cascading water moistens the surrounding area. A very characteristic species found here is *Epithema carnosum* (G. Don) Benth. which grows only in the ecological niches around mountain streams when such humid conditions exist. The plant is quite curious for its mostly singular large leaves and bluish inflorescence and grows along both sides of the mouth of the falls in the humus soil accumulated in the crevices of the rocks, moistened by the spray from the falls. Surrounding the falls, in the wet soil are plants like *Aneilema montanum* (Wt.) Clarke, *Commelina benghalensis* Linn., *Murdannia zeylanica* (Clarke) Bruck. var. *longicapsa* (Clarke) Rolla Rao et Kammathy, *Cyperus castaneus* Willd., *Cyperus iria* Linn., *Fimbristylis ovata* (Burm.f.) Kern, *Paspalidium flavidum* (Retz.) A. Camus, *Lindernia ciliata* (Colsm.) Pennell, *L. antipoda* (Linn.) Alston, *L. crustacea* (Linn.) F. Muell. and *Eragrostis tenella* (Linn.) P. Beauv. which grows as a tufted semiaquatic plant at Swamiar falls is purely mesophytic in dry habitats on the way to Tekkumalai. Similar is the case of *Paspalidium flavidum* (Retz.) A. Camus which is also found here. The rocks bordering Swamiar falls are carpeted by thalloid bryophytes which grow throughout the course of the stream on exposed wet rock surfaces. Below Swamiar falls along the sandbanks formed by the stream here and there, grows *Isachne dispar* Trin., *Fimbristylis bisumbellata* (Forssk.) Bubani and *Eragrostis gangetica* (Roxb.) Steud. which are adapted to semiaquatic conditions though they are mesophytic in several other parts of Courtallum.

Ponds:

Many ponds in Courtallum are mostly temporary and dry up during summer. The period for which they hold water varies according to the month of ceasing of rainfall and the locality where it is situated.

Thippakkulam, the pond in front of Chitrabhai in the close vicinity of Courtallum temple has been abandoned at present but was once well-maintained and considered to be of religious significance and has a 'gopuram' in its centre surrounded by water. The pond is being reclaimed by dumping wastes and crumbling of side walls and in summer it is almost dry with a marshy bottom. *Pistia stratiotes* Linn. which is a stoloniferous floating herb when the pond is full, gradually descend to the bottom as it dries up and grow gregariously in the marshy soil there. Here and there groups of *Polygonum glabrum* Willd. plants are also common in the marshy bottom of the pond. Other more frequent aquatics here are *Bacopa monnieri* (Linn.) Wettst., *Ammania baccifera* Linn., *Boerhavia diffusa* Linn. and the heterophyllous amphibious hydrophyte *Limnophylla heterophylla* (Roxb.) Benth.

In the outskirts of the forests on the way to Five falls is the pond 'Thamarakulam' which dries up in summer leaving only a marshy bed. The gently sloping marginal zone of this pond remains wet in summer bears wetland species like *Commelina ensifolia* R. Br., *Fimbristylis bisumbellata* (Forssk.) Bubani, *Pycnus globosus* (All.) Reichb., *Dactyloctenium aegyptium* (Linn.) P. Beauv., *Eriochloa procera* (Retz.) C.E. Hubb., *Dopatrium junceum* (Roxb.) Buch.-Ham., *Lindernia antipoda* (Linn.) Alston and such other weeds. The shallow middle zone of the pond which is filled with water during the rainy season forms the habitat for plants like *Nymphaea pubescens* Willd. which are anchored in the bottom of the pond with floating leaves and



●● Map showing the distribution of hydrophytes in Courtallum.

long pedicelled flowers slightly raised above the water level. Floating or rooted aquatics like *Myriophyllum oliganthum* (Wt. et Arn.) F. Muell. with submerged leaves, *Hydrilla verticillata* (Linn. f.) Royle with stoloniferous floating plant body and *Aponogeton natans* (Linn.) Engl. et E. Krause with floating leaves and stoloniferous rootstock become gregarious when the pond is filled. As the water descends these plants gradually become exposed in the marshy soil where species like *Aeschynomene indica* Linn., *Pycreus globosus* (All.) Reichb. etc. also spread.

Ditches, puddles, canals etc.:

The wet-soil plants growing in several of the moist habitats in the area are grouped under this head and it includes most of the amphibian and less characteristic species of the group. There are a number of shallow bodies of water distributed mostly towards the western part of the area along the outskirts of the forests on the way to Five falls which include small canals, gutters, damp fields, small ditches etc. In such habitats herbs like *Pedaliium murex* Linn., *Amischophacelus axillaris* (Linn.) Rolla Rao et Kammathy, *Commelina ensifolia* R. Br., *Cyperus tenuispica* Steud., *Fimbristylis bisumbellata* (Forssk.) Bubani, *Dactyloctenium aegyptium* (Linn.) P. Beauv., *Eriochloa procera* (Retz.) C.E. Hubb., *Setaria palmifolia* (Koen.) Stapf, *Dopatrium junceum* (Roxb.) Buch.-Ham., *Lindernia ciliata* (Colsm.) Pennell etc. grow. In the wet soil around the water tank above Courtallum township *Ipomoea pescaprae* (Linn.) R. Br. is a rather common species.

ECOLOGICAL CLASSIFICATION

Weaver and Clements (1929, 1939) in their broad classification of hydrophytes divided them into three groups namely, floating hydro-

phytes, submerged hydrophytes and amphibious hydrophytes. Prior to them, Agnes Arber (1920) fundamentally differentiated the group into two, i.e. plants rooted in soil and plants not rooted in soil but unattached in water. Based on their contacts with soil, water and air, Daubenmire (1947, 1956) recognised five morphoecologic groups within hydrophytes namely floating hydrophytes, suspended hydrophytes, submerged anchored hydrophytes and emergent anchored hydrophytes, essentially an elaboration of the concept of Weaver and Clements (1929). The group wet-land hydrophytes or marsh plants as recognised by Mirashi (1957), Thomas (1962) and Vyas (1964) is a further segregation of 'emergent anchored hydrophytes' of Daubenmire (1947, 1956) which according to them are plants which are transitional between hydrophytes and mesophytes that grow in wet soil where water table is close to the surface. During these studies on the hydrophytes of Courtallum, it was noted that 'marsh plants' as a group is quite flexible, and plants like *Limnophila heterophylla* (Roxb.) Benth. which grow as typical emergent anchored hydrophytes in Thippakulam when it is full is found in marshy habitats above Main falls during summer. There is no fundamental character by which the group can be differentiated from emergent anchored hydrophytes and hence it is not recognised here as a distinct group. Moreover, in the field, the circumscription of the different groups are nebulous as members belonging to one group can grow in a different habitat characteristic of another group, thus making the concept fallacious. Some of the more characteristic species coming under the various subgroups under hydrophytes are given below.

Floating hydrophytes

a. FREE-FLOATING TYPE

e.g.: *Pistia stratiotes* Linn., *Myriophyllum*

oliganthum (Wt. et Arn.) F. Muell.

b. ANCHORED HYDROPHYTES WITH FLOATING LEAVES

e.g.: *Nymphaea pubescens* Willd., *Aponogeton natans* (Linn.) Engl. et E. Krause

Submerged hydrophytes :

a. SUSPENDED HYDROPHYTES

e.g.: *Utricularia polygonoides* Edgew.

b. ANCHORED SUBMERGED HYDROPHYTES

e.g.: *Nymphaea pubescens* Willd., *Aponogeton natans* (Linn.) Engl. et E. Krause, *Polypleurum stylosum* (Wt.) J. B. Hill.

Amphibious hydrophytes :

Plants belonging to this group are described under 'emergent anchored hydrophytes' by Daubenmire (1947, 1956) and also as marsh plants by others. As a group it is not very characteristic and its members can survive in mesophytic conditions also. Such plants are quite common in Courtallum and a few examples are *Polygonum glabrum* Willd., *Aeschynomene indica* Linn., *Pouzolzia pentandra* (Roxb.) Benn., *Ludwigia octovalvis* (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven, *Bergia ammanoides* Heyne ex Roth, *Linnophila heterophylla* (Roxb.) Benth., *Pedaliu*

rex Linn., *Alternanthera sessilis* (Linn.) R. Br. ex DC., *Ammania baccifera* Linn., *Asystasia chelonoides* Nees, *Biophytum intermedium* Wt., *Boerhavia diffusa* Linn., *Canscora heteroclita* (Linn.) Gilg, *Cardamine hirsuta* Linn., *Chlorophytum laxum* R. Br., *Didymocarpus innominatus* Burt, *Drosera burmanii* Vahl, *Elatine triandra* Schkr., *Hoppea fastigiata* (Griseb.) Clarke, *Utricularia graminifolia* Vahl, *Polygala javana* DC. and several members of Scophulariaceae, Commelinaceae, Cyperaceae and Gramineae.

RELATIVE DISTRIBUTION

The table that follows gives the relative range of distribution of various hydrophytes in the different habitats of Courtallum. Several species like *Polypleurum stylosum* (Wt.) J. B. Hill, *Epithema carnosum* (G. Don) Benth., *Ludwigia octovalvis* (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven etc. are restricted to particular 'ecological niches' whereas species like *Bacopa monnieri* (Linn.) Wettst., *Commelina benghalensis* Linn. and *Lindernia* sp. flourish wherever moist situations prevail.

TABLE 1

DISTRIBUTION OF HYDROPHYTES IN THE DIFFERENT HABITATS OF COURTTALLUM

Name of the species	Habitat							
	S ₁	S ₂	S ₃	S ₄	S ₅	P ₁	P ₂	M
<i>Aeschynomene indica</i> Linn.	—	—	—	—	+	—	—	+
<i>Alternanthera sessilis</i> (Linn.) R. Br. ex DC.	—	+	—	—	+	—	—	+
<i>Amischophacelus axillaris</i> (Linn.) Rolla Rao et Kammathy	—	+	—	—	+	—	—	+

Streams and their banks: S₁—In Tekkumalai; S₂—From Shembagadevi to Main falls; S₃—Chittaruvi, Tiger falls, Old Courtallum falls; S₄—New falls;

S₅—Five falls to Swamiar falls.
Ponds: P₁—Thippakkulam; P₂—Thamarakulam.
Puddles, ditches, canals, etc.: M (miscellaneous)

HYDROPHYTIC VEGETATION OF COURTALLUM

Name of the species	Habitat							
	S ₁	S ₂	S ₃	S ₄	S ₅	P ₁	P ₂	M
<i>Ammania baccifera</i> Linn.	—	—	—	—	—	+	—	+
<i>Ancilema montanum</i> (Wt.) Clarke	—	+	—	—	+	—	—	—
<i>Aponogeton natans</i> (Linn.) Engl. et E. Krause	—	—	—	—	—	—	+	—
<i>Asystasia chelonoides</i> Nees	—	—	—	—	+	—	—	—
<i>Bacopa monnieri</i> (Linn.) Wettst.	—	+	+	—	+	+	+	+
<i>Bergia ammanoides</i> Heyne ex Roth	—	+	+	+	+	—	—	—
<i>Biophytum intermedium</i> Wt.	+	—	—	—	—	—	—	—
<i>Boerhavia diffusa</i> Linn.	—	—	—	—	—	+	—	—
<i>Canscora heteroclita</i> (Linn.) Gilg	—	+	—	—	—	—	—	—
<i>Cardamine hirsuta</i> Linn.	—	+	—	—	—	—	—	—
<i>Chlorophytum laxum</i> R. Br.	—	+	—	—	—	—	—	—
<i>Commelina benghalensis</i> Linn.	+	+	+	+	+	+	+	+
<i>Commelina ensifolia</i> R. Br.	+	—	+	—	+	—	—	—
<i>Commelina paludosa</i> Bl.	+	—	—	—	—	—	—	—
<i>Cyanotis cristata</i> (Linn.) D. Don	—	—	+	—	—	—	—	—
<i>Cyperus castaneus</i> Willd.	—	—	—	—	+	—	—	—
<i>Cyperus exaltus</i> Retz.	—	+	—	—	—	—	—	—
<i>Cyperus iria</i> Linn.	—	—	—	—	+	—	—	—
<i>Cyperus pilosus</i> Vahl	—	—	+	—	—	—	—	—
<i>Cyperus tenuispica</i> Steud.	—	—	—	+	+	—	—	+
<i>Dactyloctenium aegyptium</i> (Linn.) P. Beauv.	—	—	—	—	+	—	—	—
<i>Didymocarpus innominatus</i> Burt	—	+	—	—	—	—	—	—
<i>Dopatrium junceum</i> (Roxb.) Buch.-Ham.	—	—	—	—	+	—	—	+
<i>Drosera burmanii</i> Vahl	—	+	—	—	—	—	—	—
<i>Echinochloa colonum</i> (Linn.) Link	+	+	—	—	—	—	—	—
<i>Elatine triandra</i> Schkr.	—	+	—	—	—	—	—	+
<i>Eleocharis capitata</i> (Linn.) R. Br.	—	—	—	—	+	—	—	+
<i>Epithema carnosum</i> (G. Don) Benth.	—	—	—	—	+	—	—	—
<i>Eragrostis gangetica</i> (Roxb.) Steud.	+	+	—	—	+	—	—	—
<i>Eragrostis tenella</i> (Linn.) P. Beauv.	—	+	—	—	+	—	—	—
<i>Eriochloa procera</i> (Retz.) C. E. Hubb.	+	—	—	—	+	—	—	—
<i>Eriocaulon truncatum</i> Harm. ex Mart.	—	+	—	—	—	—	—	—
<i>Eriocaulon quinquangulare</i> Linn.	—	+	—	+	—	—	—	—
<i>Fimbristylis bisumbellata</i> (Forssk.) Bubani	—	+	—	—	+	—	—	+
<i>Fimbristylis ovata</i> (Burm. f.) Kern	—	—	—	—	+	—	—	+
<i>Hoppea fastigiata</i> (Griseb.) Clarke	—	+	—	—	—	—	—	—
<i>Hydrilla verticillata</i> (Linn. f.) Royle	—	—	—	—	—	+	+	+
<i>Hydrolea zeylanica</i> (Linn.) Sweet	—	+	—	—	—	—	—	—
<i>Ipomoea cairica</i> (Linn.) Sweet	—	+	—	—	—	—	—	—
<i>Ipomoea pescaprae</i> (Linn.) R. Br.	—	+	—	—	—	—	—	—
<i>Isachne dispar</i> Trin.	—	—	—	—	+	—	—	+
<i>Lindernia antipoda</i> (Linn.) Alston	—	+	+	—	+	—	—	+
<i>Lindernia ciliata</i> (Colsm.) Pennell	—	+	—	—	+	—	—	—
<i>Lindernia crustacea</i> (Linn.) F. Muell.	—	+	—	—	+	—	—	—
<i>Lindernia pusilla</i> (Willd.) Boldingh	—	+	—	—	—	—	—	—
<i>Ludwigia octovalvis</i> var. <i>sessiliflora</i> (Mich.) Raven	—	—	—	+	—	—	—	—
<i>Ludwigia perennis</i> Linn.	—	+	—	—	—	—	—	—
<i>Mariscus compactus</i> (Retz.) Druce	—	+	—	—	—	—	—	—

Name of the species	Habitat							
	S ₁	S ₂	S ₃	S ₄	S ₅	P ₁	P ₂	M
<i>Mariscus panicens</i> (Rottb.) Vahl	-	+	-	-	-	-	-	-
<i>Mariscus squarrosus</i> (Linn.) Clarke	-	-	+	-	-	-	-	-
<i>Murdannia dimorpha</i> (Dalz.) Bruck.	-	+	-	-	-	-	-	-
<i>Murdannia loriformis</i> (Hassk.)	-	+	-	-	-	-	-	-
Rolla Rao <i>et</i> Kammathy								
<i>Murdannia zeylanicum</i> var.	-	-	-	-	+	-	-	-
<i>longicapsa</i> (Clarke) Rolla Rao <i>et</i> Kammathy								
<i>Myriophyllum oliganthum</i> (Wt. <i>et</i> Arn.) F. Muell.	-	-	-	-	-	+	-	+
<i>Nymphaea pubescens</i> Willd.	-	-	-	-	-	-	+	-
<i>Oxalis corymbosa</i> DC.	+	-	-	-	-	-	-	-
<i>Paspalidium flavidum</i> (Retz.) A. Camus	-	-	-	-	+	-	-	-
<i>Paspalum conjugatum</i> Berg.	+	-	-	-	-	-	-	-
<i>Pedaliium murex</i> Linn.	-	+	-	-	-	-	-	-
<i>Pistia stratiotes</i> Linn.	-	-	-	-	-	+	-	-
<i>Polygala javana</i> DC.	-	-	+	-	-	-	-	-
<i>Polygonum glabrum</i> Willd.	-	-	+	-	-	+	-	+
<i>Polylepium stylosum</i> (Wt.) J. B. Hill	+	-	-	-	-	-	-	-
<i>Pouzolzia pentandra</i> (Roxb.) Benn.	-	-	+	-	-	-	-	-
<i>Pycnus globosus</i> (All.) Reich.	-	-	-	-	+	-	-	+
<i>Scirpus supinus</i> Linn.	-	+	-	-	-	-	-	-
<i>Setaria palmifolia</i> (Koen.) Stapf	-	-	-	-	+	-	-	+
<i>Sopubia delphinifolia</i> (Roxb.) D. Don.	-	-	+	-	-	-	-	-
<i>Sporobolus diander</i> (Retz.) P. Beauv.	-	+	-	-	-	-	-	-
<i>Utricularia graminifolia</i> Vahl	-	+	-	+	-	-	-	-
<i>Utricularia polygonoides</i> Edgew.	-	-	+	-	-	-	-	-
<i>Utricularia striatula</i> Sm.	-	-	-	-	+	-	-	-
<i>Xyris pauciflora</i> Willd.	-	+	-	-	-	-	-	-

PHENOLOGY

An observation made during the present study of the hydrophytes of Courtallum is the relationship between climatic conditions and physiological functions like flowering. The relative abundance of different hydrophytic plants flowering in different months of the year has been analysed and the results are represented graphically (Fig. 2). A maximum number of aquatic plants in Courtallum flower during the months of September, October, November and December, i.e. towards the end or after the South-West monsoon. This agrees with the observation of Went (1957) that

rain has a more profound influence in the flowering of tropical plants than any other factor. The increased diurnal temperature during the months following precipitation also enhance flowering. Thus a maximum number of hydrophytes in Courtallum flower in the month of November and in April it is the minimum, marking the 'true summer' for hydrophytes as rain ceases by January or February.

DISCUSSION AND CONCLUSIONS

From the distribution of the various hydrophytes at Courtallum, it is evident that certain

species grow only in one habitat, i.e. pond, puddle or stream-bank at a particular place. This preference of habitat is mainly based on the ecological group the plant belongs and it forms the basis of those 'associations' recognised as characteristic of the type of vegetation. Thus several aquatic and amphibious 'associations' are recognised within the group 'hydrophytes' by different authors and each such 'association' is described to possess a characteristic floristic composition and is named after the dominant species forming it. But as understood from the studies of the hydrophytes at Courtallum, the concept of grouping plants into any such association is fallacious. For no physiological relationship or similarity in structure or composition is exhibited by the members in such habitats and any of them can survive in a similar situation or 'ecological niche' with entirely different floristic compon-

ents around. This is the reason why some plants are common to two or more so called 'associations' which itself shows the flexibility of the group.

Although not strictly hydrophytic, the flora surrounding cascades and waterfalls as included in this group deserves special mention. The name 'water mountain plants' is proposed for the group by van Steenis (1965) and such plants find their natural habitat near waterfalls which has got a 'cool micro-climate' around it. The swiftly drifting flow usually keeps away from the rock surface for about 0.5 to 2 metres when it reaches the bottom, and the gap thus formed is peculiarly conditioned to lodge certain plants like *Utricularia striatula* Sm., *Epithema carnosum* (G. Don) Benth., species of *Impatiens* etc. some of which are sappy in nature. Due to the continuous spray of water from the falls, the rock surface is always wet and thus the vegetation on its face is distinctly zoned according to the availability of water. A maximum development of microclimate plants of this kind is at Swamiar falls and New falls. The species which grow in such habitats, complete their life-cycle within a month or two after the second monsoon, as the climate here gradually becomes more drier.

The occurrence of the species *Ipomoea pescaprae* (Linn.) R. Br. spreading in large areas along the deltas below the Main falls is significant in the vegetation type of Courtallum. Typically the species is found along sandy sea-shores and van Steenis (1965) while dealing with the beach formations of Java distinguished it as the 'pescaprae formation'. The plant is semiaquatic in Courtallum and the 'pescaprae formation' here helps to bind sand from being washed away in torrential monsoon flow. A characteristic nature of the plant is the presence of a spongy tissue inside the

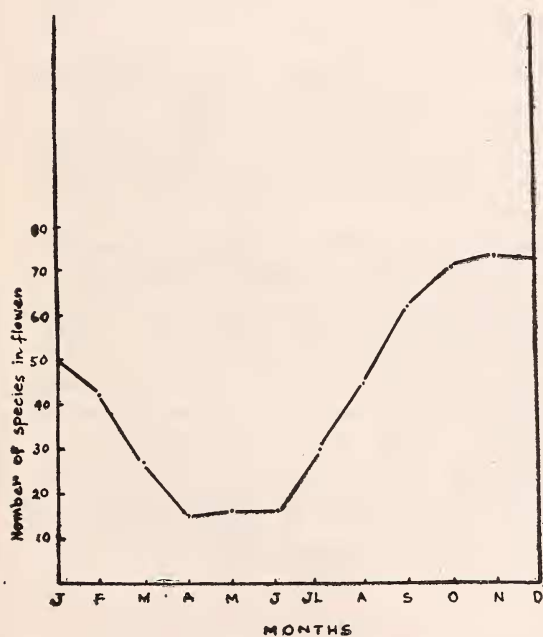


Fig. 2. Graph showing the number of hydrophytes flowering in each month of the year.

stem with a hollow in the centre. As the deltas below Main falls are submersible in monsoon, the plants complete their life cycle by the onset of rainy season.

Summing up, the total number of hydrophytic plants recorded from Courtallum is about 76 angiosperm taxa as given in the table showing the relative distribution of each. From a conservation point of view the habitat and vegetation type of the area is quite significant for the presence of those characteristic species like *Epithema carnosum* (G. Don) Benth, *Polypleurum stylosum* (Wt.) J. B. Hill, *Ludwigia octovalvis* Raven subsp. *sessiliflora* (Mich.) Raven, *Canscora heteroclita* (Linn.) Gilg, *Didymocarpus innominatus* Burt, etc. Such plants with special habitat requirements need protection by way of preserving their 'ecological niche', which otherwise is likely to get extinct soon. Those water mountain plants

like *Utricularia striatula* Sm., *U. graminifolia* Vahl, *U. polygonoides* Edgew., *Impatiens* sp., *Epithema carnosum* (G. Don) Benth. etc. grow only in the 'micro-climate' around water falls and are very sensitive to slight changes in the environment. Courtallum being an important part of the monsoon land in the Western Ghats with several water falls and cascades can serve as an area for the preservation of those rare aquatics which require special humid habitats in a mountainous environment.

ACKNOWLEDGEMENTS

My sincere thanks to Dr. M. P. Nayar, formerly Keeper, Central National Herbarium, Botanical Survey of India, Howrah for his guidance during this study and to the Director, Botanical Survey of India for all facilities.

REFERENCES

- ARBER, A. (1920): Water Plants. A study of aquatic Angiosperms. Cambridge.
- BEADLE, N. C. W. (1952): Ecological classification and nomenclature. *Proc. Linn. Soc. London (n.s.)* 77: 61-82.
- DAUBENMIRE, R. F. (1947): Plants and Environment (ed. 2, 1956). New York.
- FASSETT, N. C. (1940): A Manual of Aquatic Plants. New York & London.
- MIRASHI, M. V. (1957): Studies in the hydrophytes of Umed. *J. Indian Bot. Soc.* 36: 396-407.
- MUENSCHER, W.C. (1944): Aquatic Plants of United States. New York.
- SAXTON, W. T. (1924): Phases of vegetation under monsoon conditions. *J. Ecol.* 12: 1-38.
- STEENIS, C. G. G. J. VAN (1965): In Backer, C.A. & R.C. Bakhuizen van den Brink, Flora of Java vol. 2 (Introductory part). Netherlands.
- SUBRAMANYAM, K. (1962): Aquatic Angiosperms. *Bot. Mon. no. 3. C.S.I.R.* New Delhi.
- & NAYAR, M. P. (1974): Vegetation and Phytogeography of Western Ghats: in *Ecology and Biogeography in India*. (edited by M. S. Mani) pp. 178-196.
- THOMAS, K. J. (1962): A survey of the vegetation of Veli (Trivandrum) with special reference to ecological factors. *J. Indian Bot. Soc.* 41: 104-131.
- THRONTHWAITES, C. W. & HARE, F. K. (1953): Climatic classification in forestry. *Unasylva* 9: 51-59.
- VYAS, L. N. (1964): Vegetation of Alwar and its neighbourhood with the north-eastern Rajasthan vegetation. *J. Indian Bot. Soc.* 43: 322-333.
- WEAVER, J. E. & CLEMENTS F. E. (1929): Plant Ecology (ed. 2, 1938). New York & London.
- WENT, F. W. (1957): The experimental Control of Plant Growth. Waltham Mass.